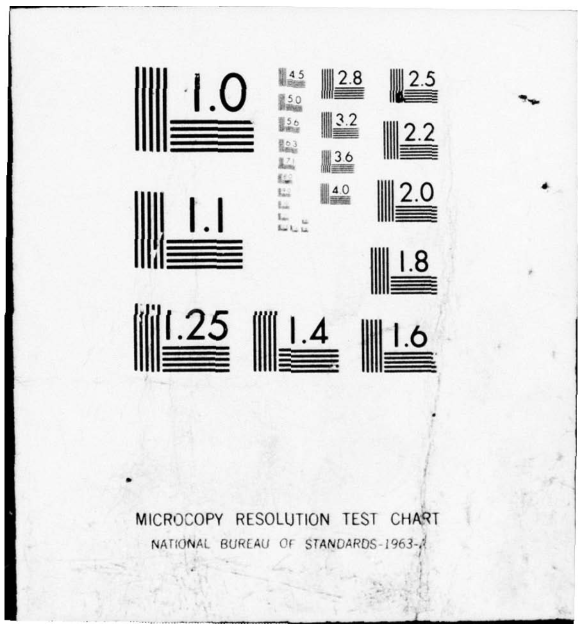
AD-A051 035 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 21/5
REDUCTION IN THE NOISE IN VICINITIES OF AIRPORTS WITH THE AID O--ETC(U)
AUG 77 V Y KVITKE, B N MELNIKOV, V I TOKAREV

UNCLASSIFIED FTD-ID(RS)T-1455-77 NL

1 OF 1
AD
A051035

END
DATE
FILMED
4-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-

FTD-ID(RS)T-1455-77

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

REDUCTION IN THE NOISE IN VICINITIES OF AIRPORTS WITH THE AID OF THE OPTIMUM METHODS OF PILOTING JET AIRCRAFT WITH TAKEOFF

by

V. Ye. Kvitke, B. N. Melnikov,
V. I. Tokarev

FOREIGN TECHNOLOGY DIVISION

FTD- ID(RS)T-1455-77

UNEDITED MACHINE TRANSLATION

FTD-ID(RS)T-1455-77 29 August 1977

MICROFICHE NR: FTD-77-C-001118

CSL74095883

REDUCTION IN THE NOISE IN VICINITIES OF AIRPORTS WITH THE AID OF THE OPTIMUM METHODS OF PILOTING JET AIRCRAFT WITH TAKEOFF

By: V. Ye. Kvitke, B. N. Melnikov, V. I. Tokarev

English pages: 70

Source: Trudy Gosudarstvennogo Nauchno-Issledovatel'skogo Instituta Grazhdan-okoy Aviatsii, Moscow, No. 74, 1972, PP. 3-37

Country of origin: USSR
This document is a machine translation
Requester: ASD/ENFPA/RON

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α α α		Nu	Ν ν
Beta	Β β		Xi	Ξ ξ
Gamma	Γ γ		Omicron	Ο ο
Delta	Δ δ		Pi	Π π
Epsilon	Ε ε ϵ		Rho	Ρ ρ ϱ
Zeta	Ζ ζ		Sigma	Σ σ ς
Eta	Η η		Tau	Τ τ
Theta	Θ θ ϑ		Upsilon	Υ υ
Iota	Ι ι		Phi	Φ φ ϕ
Kappa	Κ ϰ κ ϰ		Chi	Χ χ
Lambda	Λ λ		Psi	Ψ ψ
Mu	Μ μ		Omega	Ω ω

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

---

rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

REDUCTION IN THE NOISE IN VICINITIES OF AIRPORTS WITH THE AID OF THE OPTIMUM METHODS OF PILOTING JET AIRCRAFT WITH TAKEOFF.

V. Ye. Kvitke, B. N. Melnikov, V. I. Tokarev.

Page 3.

The increase of the noise levels in the vicinities of contemporary airports and dissatisfaction by the population living near are caused by a first of all rapid increase in the park/fleet of jet aircrafts, intensity of their operation, and also the number of airports with densly populated vicinities; by the continuous approach/approximation of habitable array to airport boundaries. Therefore it is not random the noise, created in locality, it is one of the most important operational characteristics of contemporary passenger aircraft. At the international conference on a reduction in the noise of passenger aircraft (London, 1966) it was noted that the problem of a reduction/descent in the noise on importance and in complexity of the solved questions is the second after the provision for safety of flights (1). Only the complex development and systematic introduction of the measures, which provide for a reduction in the noise in the source and not the ways of its propagation, for example, because of the creation of less noisy aircraft, application/use of special procedures of piloting, construction-planning measures and special methods of the organization of air movement, makes it possible to successfully solve this problem.

Practical propositions for the further improvement of the methods of a reduction/descent in the noise in the vicinities of airports were introduced at special conference ICAO (Montreal, 1969) on the noise of the aircraft, where, in particular, was agreed on and was accepted standard ICAO, the limiting noise during the operation of subsonic transport aircraft [2].

Page 4.

The project of similar state standard is developed in our country [3].

Along with the implementation of limitations on the noise of new passenger aircraft vital importance acquires a reduction/descent in the irritating effect of aircraft noise on population because of the perfection/improvement of the methods of the operation of contemporary aircraft.

Published work is several reworked versions of coverage, prepared for the information of the member nations of COMECON [99sp04 - Council for Mutual Economic Assistance] and executed in accordance with the branch current plan for the coordination of scientific and technical investigations, conducted by the member countries of COMECON in the range of air transport.

I. Operational methods of a reduction/descent in the noise of aircraft with takeoff.

In essence around many large airports are close habitable arrays with the high density of population. The introduction of limitations on noise and the zoning of the vicinities of airports in the future will lead to a considerable reduction/descent in the noise; in the present time a decrease of the irritating effect of noise is achieved because of the application/use of the special operational methods whose selection depends on local conditions, first of all on the topographic. As rule, most is effective the use of routes, not connected with the flight/span of the populated areas at low altitude. In other airports can be required other methods, which consider the factor of safety and cost-effectiveness/efficiency of flights.

The operational procedures, directed toward the lowering of noise during takeoff of aircraft, include:

a) the initial climb with considerable gradient for providing the greatest height/altitude during approach to the colonized locality;

b) a reduction in the engine power rating with flight over populated areas;

c) the execution of turns to the side from the populated areas;

d) the use preferable from the conditions of noise runways;

e) the use of the so-called routes of the minimum noise.

Page 5.

In all cases, with the exception of the second, a reduction/descent in the irritating effect of noise is achieved because of an increase in the distance between the source of noise and the populated areas or decrease in the quantity of flights above them; in the case of throttling of engines - because of a decrease in the emission/radiation by source. This method is most effective for a single-circuit and turbofan engine (TRDD [- turbofan engine]) with low bypass ratio, for which by the determining noise source is exhaust jet with comparatively high discharge velocity.

During the development of common/general/total recommendations regarding aircraft handling taking into account the enumerated methods of a reduction/descent in the noise is necessary the account of the following initial principles:

a) the methods, directed toward a decrease in the noise, must not reduce flight safety to unacceptable level;

b) the craft commander right to disregard methods on a reduction/descent in the noise, if it considers, that in diurnal situation they are unsafe. This is rightly reflected in appendices 2 and 6;

c) the methods, directed toward a reduction/descent in the noise, one should introduce only in those airports, for which the noise is really/actually problem;

d) the use of the methods of a reduction/descent in the noise must not require of the pilot of qualification higher than the average.

The need for the execution of these principles will be emphasized in the decisions of special conference ICAO on noise [4].

1. Increase in the gradient of the initial climb.

One of the important cell/elements of the special methods of piloting for a reduction/descent in the noise with takeoff of aircraft is the realization of the optimum values of gradients of the initial climb. The principle of reduction in the noise in this case is based on an increase of the distance to noise source. Flight with insignificant acceleration after liftoff and maintaining attained speed, constant in further set, it provides approximately two times the wide angles initial the climb in comparison with the flight, during which is realize/accomplished the continuous acceleration/dispersal of aircraft. Under other various conditions this reduces noise on the average up to 6 dB. During takeoff by this method there occurs the redistribution in the balance of available thrust; a large part of it is expend/consumed on the creation of vertical velocity V_y . Page 6.

With the usual takeoff with continuous acceleration/dispersal, which was being frequently applied it is earlier, for example, with the operation of twin-engine aircraft of the type Tu-104 and Tu-124, the thrust equal to the thrust approximately one engine, is expend/consumed on the creation of the increasing motion of aircraft and the same thrust - not overcoming of drag, and its only a small fraction (order 0.1 thrust of one engine) - for creation V_y [5].

For providing steep trajectory during the climb the flight speed must be constant. The characteristic value of flight speed during the steady climb must not be lower than maximum value from the number of enumerated values [4]: $1,2V_{MCA}$, $1,3V_s$ or V_2 - 20 km/h) determination of values V_{MCA}, V_s and V_2 is given in circular ICAO No 58 - AN/53/2-RAMS).

In the literature most frequently as the recommended characteristic flight speed is used the last/latter value.

The noise, created in locality during takeoff of this type aircraft, it is determined by two basic factors - by removal/distance to aircraft and by the mode/conditions of the operation of its engines.

The height/altitude of the flight/span of aircraft at the assigned removal/listance from the beginning of takeoff/run-up, and the consequently also created by it noise, they depend on six independent variables, namely [6]:

$$H = f(P, G, S, \kappa, C_{x_0}, V),$$

where R is an engine thrust; G - the weight of aircraft; S - wing area; K is the coefficient, which considers the effect of induced drag (it is determined by known relationship/ratios $C_x = C_{x_0} + C_{x_i} = C_{x_0} + \kappa C_y^2$; here K = $(\pi\lambda e)^{-1}$, where λ - relative wing aspect ratio, and coefficient e for an aircraft as a whole can vary within the limits of 0.75-0.90;

C_{x_0} - the coefficient of drag with zero lift; V is flight speed.

To evaluate the acoustic responses of aircraft taking off at the points in locality, arrange/located at removal/distance $l_0 > 5$ km of the beginning of takeoff/run-up, can be used simple and sufficiently precise correlation (Fig. 1):

$$H = (l_0 - l')\sin\theta,$$

or $H = (l_0 - l')(\bar{P} - \bar{Q})$, since $\sin\theta = \bar{P} - \bar{Q}$.

Page 7.

Here $\bar{P}=P/G$ is a thrust-weight ratio and $\bar{Q}=X/G$ - the ratio of resisting force to the weight of aircraft.

As a result of the generalization of the characteristics of a series of subsonic transport aircraft with jet engines is obtained the semi-empirical formula

$$l'=2,44\frac{G/S}{\bar{P}C_{y\,max}},$$

valid for a constant flight speed V_2 -20 km/h, where V_2 is a safe rate of climb.

Utilizing these relationship/ratios, it is easy to obtain finite formula for determining the height/altitude of the flight/span of the aircraft above the control point.

Gradient during the climb, as can be seen from the given above relationship/ratios, besides other factors, depends on the flap angle. Therefore it is considered that the height/altitude of the flight/span of the control point, arrange/located at the determined removal/distance from the beginning of takeoff/run-up, can be increased (and to consequently also lower noise) due to the selection of the optimum flap angle with takeoff.

It is known that with the preservation/retention/maintaining of the certain degree of flight safety the low flap deflection leads to increase of takeoff run length and of the angle of the initial climb. An increase in the flap angle reduces the takeoff run length, however, in this case decreases and the angle of the initial set of height/altitude (Fig. 2).

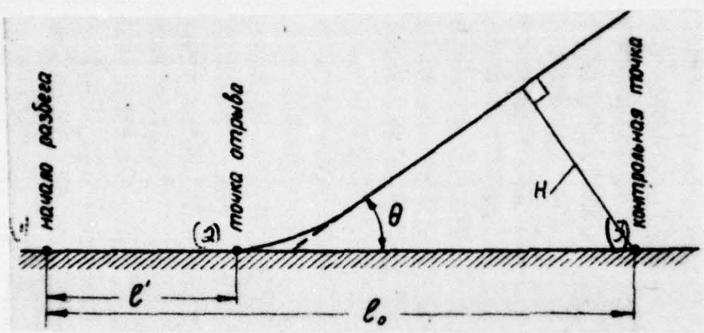


Fig. 1. Take-off path.

Key: (1). Beginning of takeoff/run-up. (2). the point of liftoff. (3). control point.

Page 8.

In connection with this (in the absence of other limitations, for example, along the length runways) it is expedient:

a) for a decrease in the noise in the zone of immediate vicinity of airport (zone 1) to utilize large flap deflection;

b) for a reduction/descent in the noise in intermediate zone 2 to utilize the optimum flap deflection;

c) for a decrease in the noise in zone 3 (eliminated from airport) to utilize low flap deflection.

The medium removal/distance of zone 2 from the beginning of takeoff run is 4.5-8 km. As a rule, the flap angle, which is accompanied by the minimum noise, is close to that recommended by "Manual on flight operation", established for other reasons.

For 1 and 3 zones a reduction/descent in the noise because of the selection of the optimum position of flaps with takeoff is low and composes I-2 TPN dB (level of the received noise with correction for the discrete components in noise spectrum).

Another method of a reduction/descent in the noise is the change in the configuration of aircraft and velocity of its flight with takeoff. For each zone in locality and for each type aircraft there is a optimum procedure, which provides for:

a) the takeoff/run-up and the initial set of height/altitude at the determined flap angle;

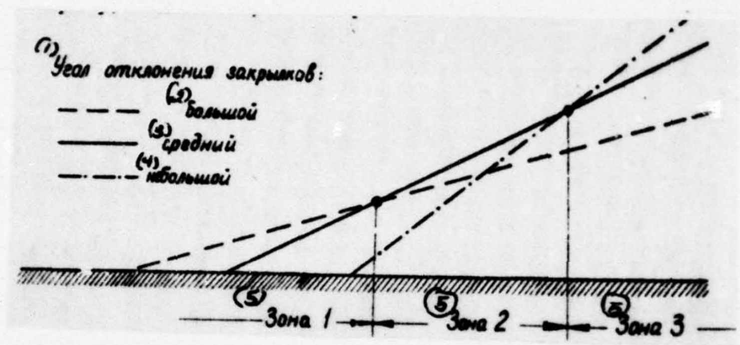


Fig. 2. Effect of the flap angle of the take-off path of aircraft.

Key: (1). Angle of flap deflection. (2). Large. (3). average. (4). small. (5). Zone ....

Page 9.

b) acceleration/dispersal with partial retraction of flaps at the determined height/altitude;

c) the climb with the optimum flap angle.

By the solution of conference ICAO on noise in the vicinities of airports it is noted [by 4] that it cannot be required in the necessary order of a change in the configuration of aircraft for the purpose only of reduction/descent in the noise with takeoff.

To Fig. 3 is shown the comparison of the path of takeoff and levels of the created noise with the takeoff of an aircraft of the type DC-8-50 with engines JT3D-3B with the maintaining of constant velocity with the flaps, deflected to takeoff position (solid lines, and the acceleration/dispersal of aircraft to speed 400 km/h with retraction of flaps (dotted lines) [7].

Sometimes for providing the standardized noise levels it is necessary to lower takeoff weight aircraft. A reduction/descent in the noise in this case is achieved because of a decrease in the takeoff run length, increase in the angle of the initial nonboron of height/altitude and relative reduction/descent in the engine power rating for maintaining the assigned gradient of climb.

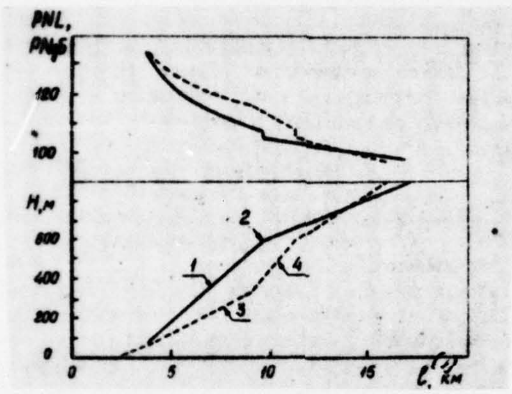


Fig. 3. Trajectories and the noise, created in locality, with the takeoff of the aircraft DC-8-50 employing different procedures (takeoff weight - 143 t, standard atmospheric conditions): 1 - climb at speed V_2 -20 km/h, the flap angle 25°; 2 - the point of the throttling/choking of engines on height/altitude 600 m; 3 - the climb with acceleration/dispersal to speed 400 km/h and retraction of flaps; 4 - speed hold 400 km/h.

Page 10.

The reduction/descent in the takeoff weight to 10o/o provides a decrease in the noise on the average by 5 TPN dB (4 EPN dB) during the use of a throttle mode/conditions, providing climb with gradient 4o/o. If for the purpose of a reduction/descent in the noise is utilized one standard engine power rating, which corresponds to gradient 4o/o with the maximum takeoff weight, then the reduction/descent in theweight to 10o/o provides with jack a decrease in the noise on the average of entire n 3.5 TPN dB (2.5 EPN dB) [4]. The reduction/descent in the takeoff noise because of a decrease in the payload is economically inexpedient. For example, in the case of the takeoff of an aircraft of the type DC-8-61 with the engines of JT3D-38 (takeoff weight - 147 t, standard atmospheric conditions) without the use of a procedure of a reduction/descent in the noise, the maximum level of noise at a distance 6 km of the beginning of takeoff/run-up reaches 120 PN by dB. For provision with the takeoff of permissible level 112 PN dB without the use of the methods of a reduction/descent in the noise it is necessary to decrease the takeoff weight of aircraft more than on 22.5 t, which for the aircraft DC-8-61 corresponds approximately to the weight of all passengers [7].

2. Throttling/choking of engines.

During approach to the colonized locality after the climb with the maximum gradient for the purpose of a reduction/descent in the noise the engines are throttled.

In accordance with requirements [2], [4] the minimum altitude of throttling/choking is accepted equal to 210 m; minimum mode/conditions is selected in such a way that at the maximum value of takeoff weight and datum temperature +25° C the positive gradient of the climb woull be not below 4o/o.

The results of application/use and the acoustic effectiveness of this method are very diverse. During an essential decrease in the noise under takeoff path on the section of the throttling/choking of engines is possible an increase of noise in the areas, arrange/located after this section in the course of takeoff. The decrease of noise, attained as a result of a reduction/descent in the engine power rating, depends substantially on the type of engines. Acoustic effectiveness with the throttling/choking of engines from takeoff mode/conditions, cooresponding to gradient 4o/o, reaches following values [4].

Page 11.

A decrease in the level of the received noise (Δ PNL), emmitted by exhaust jet with throttling/choking with sufficient for practical target/purposes accuracy/precision can be expressed by the relationship/ratio:

$$\Delta PNL = 50 \lg P/P_{м},$$

where P is an engine thrust in throttle mode/conditions; $P_{м}$ - maximum value of thrust/rod. This dependence is shown by solid line on curve/graph (Fig. 4).

The analysis will show the validity of this relationship/ratio for exhaust jets with change of their parameters in a wide range, which is characteristic for the engines of the different type and class.

Table 1.

(1) [illegible] / (2) [illegible]	(3) [illegible]	(4) [illegible]	
		I ÷ 2	5
2	8÷12	6÷8	4÷6 TPN дБ
	6÷9	5÷6,5	3,5÷5 EPN дБ
4	2÷7	3÷4	2÷3,5 TPN дБ
	I,5÷6	2÷3	I,5÷3 EPN дБ

Key: (1). Quantity of engines on aircraft. (2). Type of the used engines. (3). Turbojet. (4). Turbofan with bypass ratio.

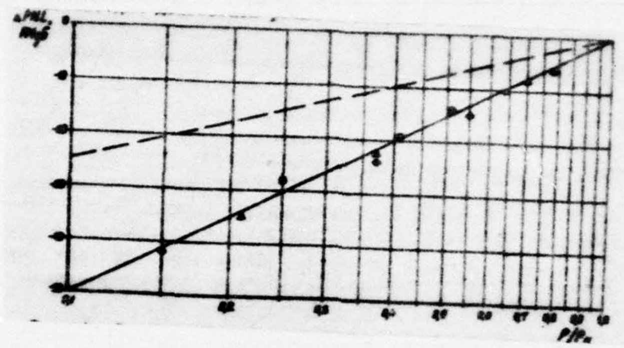


Fig. 4. A reduction/descent in the span noise of exhaust jet (solid line) and of compressor (dotted line) of DTRD [[illegible] turbofan engine] with throttling of engines (designation of points see in text, lines coincide at point $\Delta PN_{\text{ж}} = 0$ conditionally).

Page 12.

On Fig. 4 by points are represented the results of this analysis for the engines, initial parameters of which are given in table 2.

Similar dependence for the noise of compressor TRDD is shown to Fig. by 4 dotted lines:

$$\Delta PNL = 25 \lg P/P_{н} .$$

In the case of application/use TRD, intended for SPS [CCC, system with a variable structure], in the range of the mode/conditions, used in takeoff, by the basic noise source is counted exhaust jet; therefore the acoustic effectiveness of throttling/choking is maximum.

The absolute values of noise levels, emitted by exhaust jet and compressor, during a change of the engine power rating of this type in flight can be calculated by employing the existing procedures. As an example to Fi. 5 is shown similar dependence for a different height/altitude and the flight speed of aircraft with TRDD, that have low bypass ratio [8].

By utilizing the relationship/ratios, presented in section 2 and present sections, it is possible to construct the nomogram, with the aid of which is estimated the expected reduction/descent in the noise, emitted by compressor and exhaust jet taking into account the ascended vertical distance above the control point, and also the mode/conditions, utilized with the throttling/choking of engines.

Table 2.

(1) Обозначения на рис.4	(2) Тип двигателя и его назначение	(3) Тяга двигателя, т
●	(4) ТРД для СПС (бесфорсажный режим)	80
▲	(5) ТРД для дозвукового транспортного самолета	5
◆	(6) ТРДД со степенью двухконтурности около 1,5	7,25
■	(7) ТРДД со степенью двухконтурности около 6	18

Key: (1). Designations on Fig. 4. (2). Type of engine and its designation/purpose. (3). Thrust/rod of engine, t. (4). TRD for SPS (boosterless mode). (5). TRD for a subsonic transport aircraft. (6). TRDD with bypass ratio of approximately 1.5. (7). TRDD with bypass ratio of approximately 6.

Page 13.

3. Execution of turns during the climb.

The application of turns it makes it possible substantially to lower noise in the populated areas, arrange/located on the course of takeoff under trajectory or near. This one of the basic cell/elements, used when selecting the routes of the minimum noise.

In accordance with requirements ICAO [4] for the safety control of the flight turns are permissible only in such a case, when aircraft reached and it can support during turn height/altitude not less than 150 m above the level of terrain and are prevented under the flight trajectory and if roll attitude it does not exceed 15°.

Turns usually are not allow/assumed in conjunction with the throttling/choking of engines.

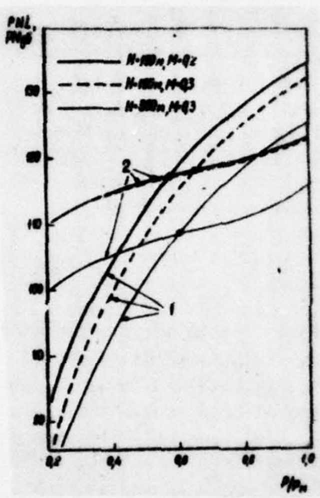


Fig. 5. Characteristic relationship/ratio between noise levels, emitted by exhaust jet and compressor with the flight/span of aircraft, equipped with DTRD with low bypass ratio, 1 - the noise of jet, 2 - the noise of compressor.

Page 14.

4. Use of preferable runways on noise.

The idea of preferable runways on noise consists in the preferred use of those takeoff headings, which are not connected with the flight/span of the close populated areas. This is possible in the presence in to the airport of several runways, separate from which in the direction of axle/axis do not have the close colonized zones, but in the case one runway - colonized point/items with one of the sides.

The application/use of a preferable runway on noise is not required [4], if the runway is covered by snow, slush or glaze, is covered with water, contamination, by oil; if transverse and incidental wind components, including gusts, exceeding respectively 7.5 and 2.5 m/s.

5. Use of routes of minimum noise.

The stimulation, produced by aircraft noise in densely-populated areas, can be decreased or eliminated completely because of the flight of aircraft in the routes, arrange/located outside these areas, or with the realization of flights above the relatively low-populated areas. In this case it is necessary to accept into consideration the cost-effectiveness/efficiency of operation in connection with possible limitations of the capacity of airport and complications in the administration moved of aircraft. If the selected routes completely do not eliminate the flight/spans above densely-populated areas, is feasible the course of the concentration of noise stimulation in small territories.

The more uniform distribution of the routes of the flight/span of aircraft for the purpose of a reduction/descent in the frequency of the effects of noise considers insufficiently effective means. As a result of sociological investigations, which lie at the basis of the used criteria of the total effect of noise, the contribution to the common/general/total stimulation, determined by noise levels, is considerably more than introduced one by a quantity of flight/spans. Thus, the total effect of noise, which the population is subjected to, is reduced with the concentration of air traffic on a minimum quantity of routes.

II. Results of experimental studies in the final adjustment of the procedures of piloting with a decrease in the noise in locality with the takeoff of aircraft of the type Tu-104, Tu-124, Tu-134 and Il-62.

In the process of special flight tests, carried out GosNII [State Scientific Research Institute] GA [Civil Aviation], are experimentally determined the characteristics of the noise of Soviet passenger aircraft and developed recommendations regarding their piloting with takeoff with decreased noise created in locality.

Page 15.

1. Decrease of noise with the takeoff of aircraft Tu-104.

The characteristics of the noise of jet aircraft, by the first in the world of that begun regular passenger transportation, will become the object/subject of investigations comparatively long [9], [10]. Most in detail the characteristics of the takeoff noise of aircraft Tu-104 are presented in work [11], and the procedure of aircraft handling with a decrease in the noise with takeoff is given in works [12], [13], [14].

For the purpose of a decrease in the noise with ballet with course of the populated area the craft commander is guided by the following.

The selection of the position of flaps, takeoff/run-up, breakaway, landing gear retracting are conducted in accordance with recommendations. "Manuals on flight operations and aircraft handling". After breakaway the aircraft is accelerate/dispersed without maintaining with the climb to speed 350 km/h for a takeoff weight 72 t and more; 340 km/h - for a weight less than 72 t.

At height/altitude 200 m after completion of landing gear retracting the engine power rating from takeoff is translate/transferred into nominal. Further climb 500 m is conducted depending on takeoff weight at constant velocity 350 or 340 km/h by those which were deflected on 10° flaps.

After achieving height/altitude 500 m, aircraft it is accelerate/dispersed, and at speed 370-380 km/h flaps are removed with the realization of further acceleration to speed 600 km/h according to instrument. Before the termination of the landing gear retracting and flaps the flight speed must not exceed 400 km/h.

With takeoff toward the populated areas, eliminated less than on

6 km from the beginning of takeoff/run-up, it is necessary after completion of landing gear retracting at height/altitude 200 m to change the engine power rating from maximum in mode/conditions r/min. The flight/span of the populated areas is fulfilled at constant velocity 350 or 340 km/h. After the flight/span of habitable array or set of height/altitude 500 m it is necessary to transfer engines to the nominal rating of work, accelerate aircraft to speed 370-380 km/h, to remove flaps and to produce the further acceleration to speed 600 km/h.

With takeoff from foreign airports with the established/installed limitations on noise, in all cases with takeoff in the night time, when allowable noise levels substantially lower, it is necessary with the aid of graphs, shown to Fig. 6 and Fig. 7, to test the created noise levels and, if it is necessary, to determine for these conditions the height/altitude of a change in the engine power ratings and the mode/conditions, which ensures acceptable noise levels (for example, 110 -112 PN dB in the daytime even 102 PN dB at night).

Page 16.

In these cases is allow/assumed a decrease in the mode/conditions not below $n = 4100$ об/мин. after completion of landing gear retracting and at height/altitude not less than 150 m. In all cases the climb under maximum conditions of the operation is recommended to produce to height/altitude 250-300 m.

The height/altitude of a change in the engine power rating and the mode/conditions, which ensures noise levels, close to allowable, are determined from the initial data, which includes the actual takeoff weight of aircraft, temperature of air of the earth/ground, that chomprises wind velocity along runway the removal/distance of the populated point from the beginning of takeoff/run-up.

The combined effect of the first three parameters is considered through the conditional concept "the given weight), determined with the aid of curve/graph (see Fig. 6).

On the curve/graph, shown to Fig. 7, from the point, which corresponds to the distance of the nearest boundary of the populated area from the beginning of takeoff/run-up on the course of takeoff, is carried out vertical line before intersection with trajectory, that corresponds to the obtained given weight.

Horizontal line, drawn to the side of the arranged/located to the right table of the levels of the created in locality noise, indicates the expected level depending on the engine power rating.

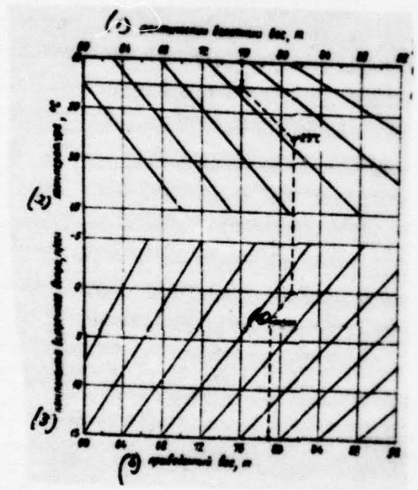
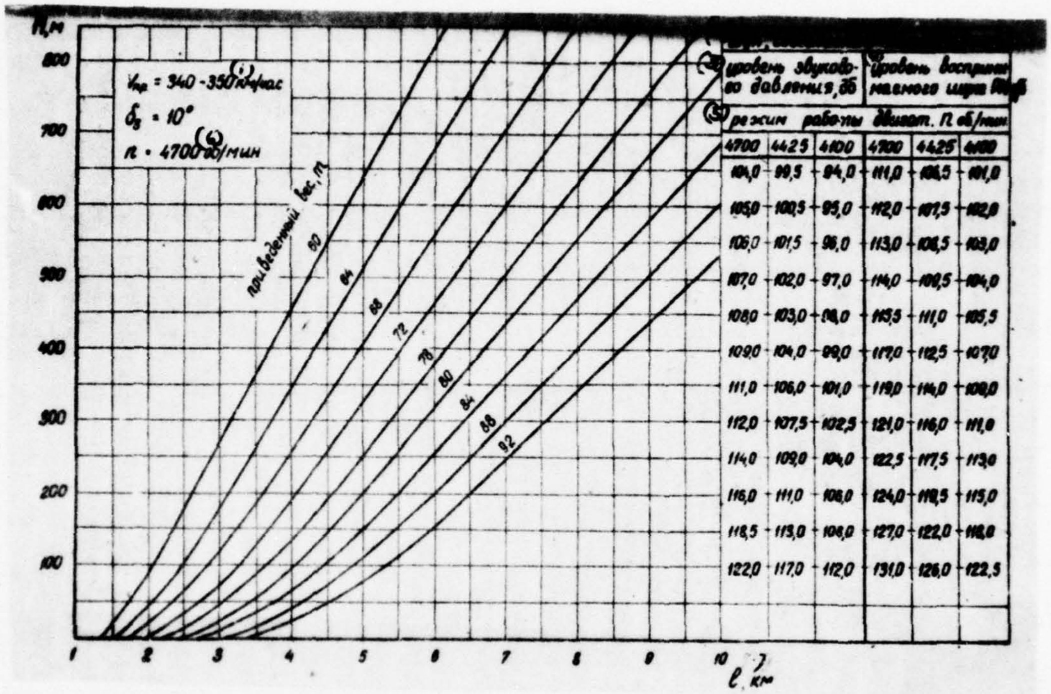


Fig. 6. Nomogram for determining the provided weight of aircraft Tu-104.

Key: (1). Actual takeoff weight, t. (2). temperature, °C. (3). Headwind component, m/s. (4). given weight, t. (5). m/s.

Page 17.



уровень звукового давления, дб			уровень воспринимаемого шума ПНдб		
режим работы двигат. n об/мин					
4700	4425	4100	4700	4425	4100
104,0	99,5	94,0	111,0	106,5	101,0
105,0	100,5	95,0	112,0	107,5	102,0
106,0	101,5	96,0	113,0	108,5	103,0
107,0	102,0	97,0	114,0	109,5	104,0
108,0	103,0	98,0	115,5	111,0	105,5
109,0	104,0	99,0	117,0	112,5	107,0
111,0	106,0	101,0	119,0	114,0	109,0
112,0	107,5	102,5	121,0	116,0	111,0
114,0	109,0	104,0	122,5	117,5	113,0
116,0	111,0	106,0	124,0	119,5	115,0
118,5	113,0	108,0	127,0	122,0	118,0
122,0	117,0	112,0	131,0	126,0	122,5

Fig. 7. Trajectories and the noise, created in locality with the

takeoff of aircraft that-104.

Key: (1). km/h. (2). Noise, created on locality. (3). level of sound pressure, dB. (4). the level of the received noise PN. (5). conditions of operating eng. P r/min. (6). r/min. (7). km.

Page 18.

An example of the calculation is shown on the curve/graphs by dotted line with rifleman/pointers for the following conditions:

takeoff weight of aircraft. . . . . -76 t,

the temperature of air. . . . .-+25°C,

the is component of head wind. . . - 3 m/s,

the removal/distance of the boundary/interface of the populated area from the beginning of takeoff/run-up. . . . -5.5 km.

Under these conditions the given weight is equal to 79 t. For providing accepted as that permissible for a daytime in datum to the airport of the level, for example, 112 PN dB, decrease the engine power rating down to n = 4100 r/min it is necessary to execute at altitude 250 m, continuing climbing flight at speed 350 km/h. After the flight/span of the populated area or set of height/altitude 500 m the engines are translate/transferred into the nominal rating of work and in the process of the acceleration/dispersal of aircraft are removed flaps.

For the purpose of a supplementary reduction/descent in the noise in locality is permitted the execution of turns away from the populated areas at height/altitude not less than 200 m with bank not more than 20°.

To Fig. 8 are shown to trajectory and the created maximum noise above the trajectory with the takeoff of aircraft 70 t in weight under standard atmospheric conditions according to the procedure with a decrease in the noise (climb with speed hold V_{np}= 340 km/h) during the different engine power ratings and according to the procedure, which was being applied earlier and which provides for acceleration/dispersal with further speed hold 400 km/h (dotted lines).

2. Decrease in the noise with the takeoff of aircraft Tu -124.

The results of the investigations of the characteristics of the noise of aircraft Tu -124, and also investigations in the final adjustment of the procedure of piloting with a decrease in the noise not of locality with the takeoff of aircraft are examined in detail in works [5], [12], [13], [14], [15].

At airports with the closely spaced populated points for a decrease in the noise in locality, the created with takeoff aircraft Tu -124, the initial climb after landing gear retracting is conducted at speed 300 km/h to height/altitude 500 m. At height/altitude 300 m the engines are translate/transferred into the nominal rating. After climb 500 m due to decrease of the rate of climb aircraft is accelerate/dispersed to speed 320-350 km/h and is conducted retraction of flaps.

With takeoff to the side of the populated areas, arrange/located at distance less than 4 km on the course of jack of the beginning of takeoff/run-up, in all cases with after taking off night time, in also during flight from foreign airports with the established/installed limitations on noise is necessary by the curve/graphs, shown on Fig. 9, Fig. 10, to check created levels of noise m, if it is necessary, to determine under the diurnal conditions of takeoff (takeoff weight, the meteorological conditions and the removal/distance of the populated area from the beginning of takeoff/run-up) the height/altitude of a change in the engine power rating and the mode/conditions, which ensures acceptable noise levels. For these purposes is allow/assumed a decrease in the engine power rating not below 88o/o after completion of landing gear retracting and on height/altitude not less than 150 m.

For the purpose of a supplementary reduction/descent in the noise is permitted the execution of turns to the side from the populated areas at height/altitude not less than 200 m, also, with bank not more than 20°.

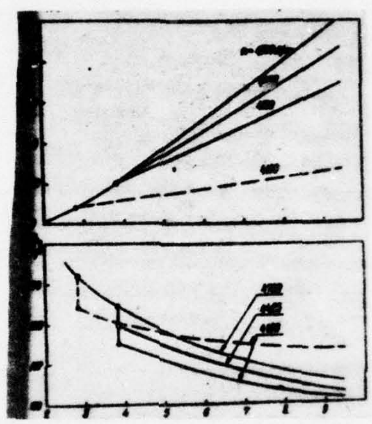


Fig. 8. Characteristic trajectories and the noise, created in locality with the takeoff of aircraft Tu-104 employing different procedures.

Page 20.

3. Decrease in the noise with the takeoff of aircraft Tu-134.

For the purpose of a decrease in the noise with the takeoff of aircraft Tu-134 with course of the colonized locality it is necessary to be guided by the following.

The selection of the position of flaps, takeoff/run-up, breakaway, landing gear retracting are conducted in accordance with the recommendations of "management/manual on flight operations and aircraft handling". After breakaway in the process of landing gear retracting the aircraft is accelerate/dispersed without speed hold according to instrument 280-290 km/h for the flaps, deflected to 20°, and 300 km/h - for the flaps, deflected to 10°. Futher climb 800 m is conducted at the constant indicated speed 280-300 km/h depending on the flap angle for all takeoff weights to 45 t inclusively.

With takeoff into daytime burden and in the case, when the removal/distance of the populated area exceeds 6 km of the beginning of takeoff/run-up, it is necessary at height/altitude 400 m to change the engine power rating from takeoff to nominal. At height/altitude 800 m the stabilizer will be transpose/rearranged into position "0", aircraft is accelerated to the recommended by "manual" speeds. In the process of acceleration/dispersal by speed 330 km/h is conducted the retraction of flaps.

With takeoff in night time, and also to the side of the populated areas, arrange/located at removal/distance it is less than 6 km, and during flight from the foreign airports, in which are establish/installed the limitations on noise, it is necessary by the accompanying curve/graphs (Fig. 11, Fig. 12) to determine the expected noise levels, and, if necessary to refine for these conditions (takeoff weight, the meteorological conditions and the arrangement of the populated areas) the height/altitude of a change in the engine power rating and the mode/conditions, which ensures acceptable noise levels.

In these cases is allow/assumed a decrease in the mode/conditions not below 88o/o after completion of landing gear retracting and at height/altitude on less than 150 m. In this case in all cases the aircraft must continue the climb with rate of climb not less than 2.5 m/s.

The height/altitude of a change in the engine power rating and the mode/conditions, providing noise levels, close to permissible, are determined from the fact initial data, as for an aircraft Tu-104. Their combined effect is considered with the aid of the curve/graph, given to Fig. 11.

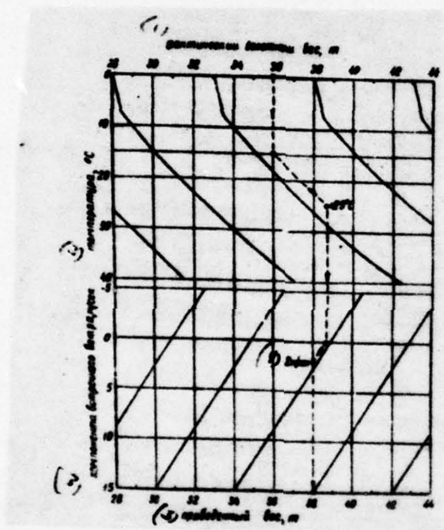
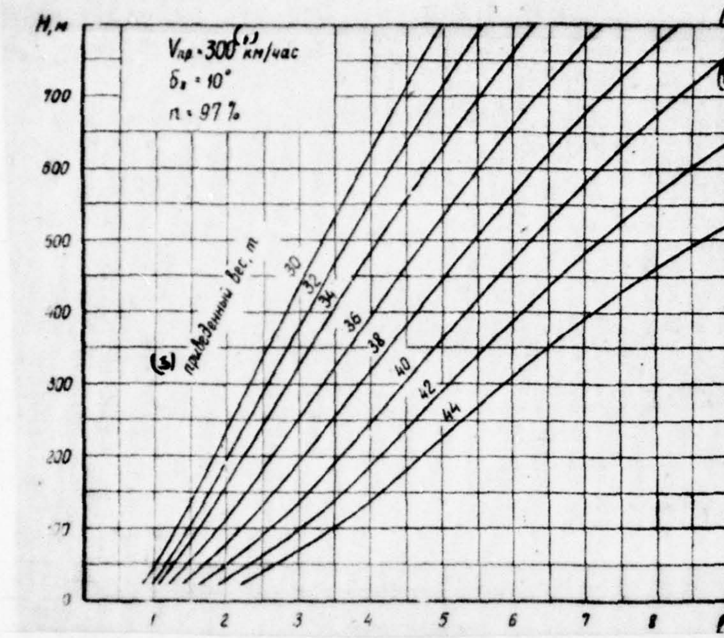


Fig. 9. Nomogram for determining the given weight of aircraft Tu-124.

Key: (1). actual takeoff weight, t. (2). temperature, °C. (3). Headwind component, m/s. (4). m/s. (5). given weight, t.



(2) уровень звукового давления, дБ			(3) уровень воспринимаемого шума PNдБ		
(4) режим работы двигателей n%					
97	93	88	97	93	88
101,0	94,5	90,5	107,0	101,5	98,0
101,5	96,0	91,0	107,5	102,5	98,5
102,0	97,0	91,5	108,5	103,5	99,5
103,0	98,0	93,0	109,5	104,5	100,5
104,0	99,0	94,0	110,5	106,5	101,5
105,0	101,0	95,5	111,5	108,0	103,0
106,0	102,0	97,0	113,0	109,5	104,0
107,0	104,0	98,5	114,5	111,5	106,5
108,5	105,5	100,5	116,0	113,5	108,5
110,5	107,0	102,5	118,0	115,5	110,5
113,0	109,5	105,5	121,5	118,0	114,0
116,5	112,5	108,5	125,5	122,0	118,5

Fig. 10. Trajectories and the noise, created in locality with the takeoff of aircraft Tu-124.

Key: (1). km/h. (2). the sound pressure level, dB. (3). the level of the received noise, (4). the engine power rating, p o/o. (5). given weight, t. (6). km.

Page 22.

For ietermining the given weight it is necessary above according to horizontal scale to find the value of actual takeoff weight and to conduct vertical line to intersection with the horizontal line, which corresponds to temperature of +15°C, then from point of intersection to conduct the line, parallel to the closest inclined ray/beam, to the value of actual temperature of the earth/ground. After conducting vertical line from the obtained point to the horizontal line, which corresponds to calm, in a similar manner we produce the account of wind on runway. For lower scale we obtain corresponding to these conditions the given weight of aircraft.

On curve/graph (Fig. 12) from the point, which corresponds to the distance of the nearest boundary/interface of the populated area from the beginning of takeoff/run-up on the course of takeoff, is carried out vertical line before intersection with the trajectory, which corresponds to the obtained given weight. Horizontal line, drawn to the side of the arranged/located to the right table of the levels of the created in locality noise, it will indicate the expected level depending on the engine power rating.

An example of the calculation is shown on the given curve/graphs by dotted line with rifleman/pointers for the following conditions:

the takeoff weight of aircraft. . . . . - 44 t,

the temperature of air. . . . .-+30°C,

the is component of head wind. . . . - 5 m/s,

atmospheric pressure. . . . .-730 mm Hg,

distance of the boundary/interface of the populated area from the beginning of takeoff run . . . .- 4 km.

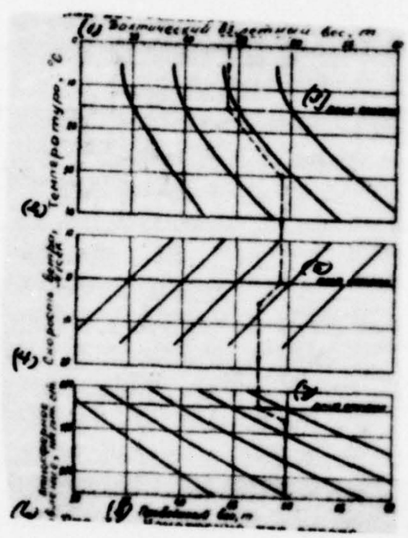


Fig. 11. Nomogram for determining the given weight of aircraft Tu-134.

Key: (1). Actual takeoff weight t. (2). Temperature, °C. (3). reference line. (4). Speed of wind, m/s. (5). reference line. (6). Velocity of wind, m/s. (7). reference line. (8). given weight, t.

Page 23.

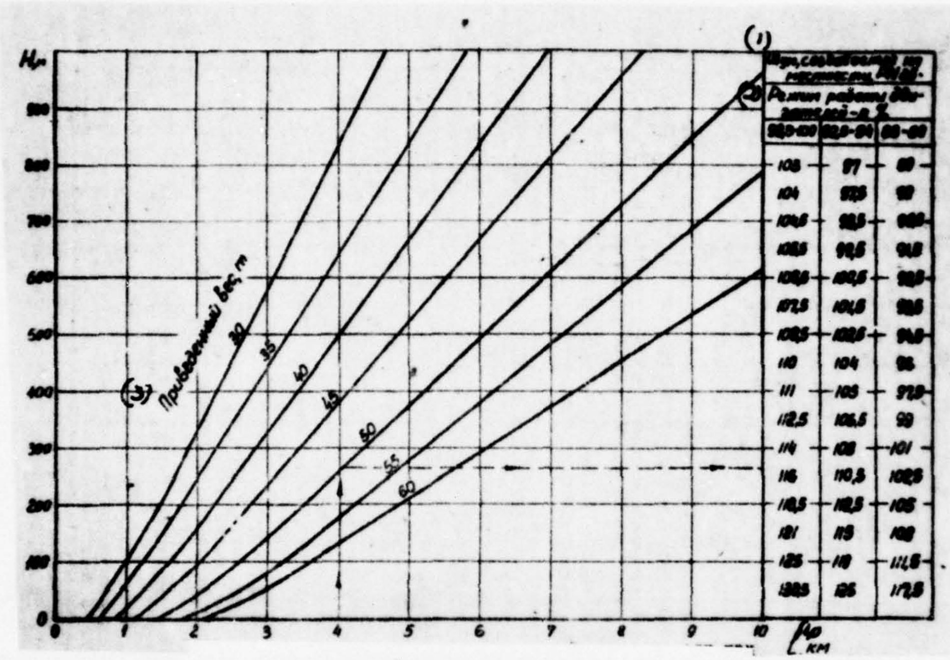


Fig. 12.

Fig. 12. Trajectories and the noise, created in locality with the takeoff of aircraft Tu-134.

Key: (1). Noise, created in locality, PN dB. (2). Engine power rating - p o/o. (3). Given weight, t. (4). km.

Page 24.

In this case the given weight is close to 50 t. For providing accepted as that permissible for a daytime in datum for the airport level, for example, 102 PN dB, decrease in the engine power rating down to n = 88o/o are necessary to manufacture at height/altitude approximately 200 m, continuing climbing flight at speed 280-290 km/h. After the flight/span of the populated point of climb 800 m the engines are translate/transferred into the nominal rating of work and in the process of acceleration of aircraft at speed 330 km/h on instrument are removed flaps.

The given to Fig. 11 and 12 curve/graphs are suitable also to evaluate the noise levels and in the case of the takeoff of aircraft with the flaps, deflected to 10° (gradient of the climb in this case is somewhat higher than with takeoff with the flaps, deflected by 20°).

Sometimes for the purpose of a supplementary reduction/descent in the noise is allow/assumed the execution of turn away from populated points at height/altitude not less than 100 m above the level of airfield with bank not more than 15°.

4. A decrease in the noise with takeoff of aircraft Il-62.

Some results of the investigations of the characteristics of the noise of aircraft Il-62 and recommendations in its reduction/descent are published in [11], [16].

For the purpose of reduction of noise in locality with the takeoff of aircraft the Il-62 with course of the colonized locality is applied at present the following procedure.

the position of flaps, takeoff/run-up, breakaway and the landing gear retracting of aircraft after being conducted in accordance with the recommendations of section "takeoff" of "management/manual on flight operations".

In the process of landing gear retracting the aircraft is accelerate/dispersed to the speed 320-340 km/h depending on takeoff weight.

(1) Взлетный вес, т	(2) I30 и менее	I40	I60
(3) Скорость по прибору, км/час	320	330	340

Key: (1). Takeoff weight, t. (2). ... and less. (3). Indicated airspeed, km/h.

Page 25.

At height/altitude 120 m in the process of the further acceleration/dispersal of aircraft to speed 350 km/h for takeoff weights to 150 t inclusively and to 360 km/h for weights 150-160 t begins the retraction of flaps from 30° to 15°.

With takeoff in daytime and in the case, when the removal/distance of the populated area exceeds 6.5 km of the beginning of takeoff/run-up, at height/altitude 400 m the engine power rating is translate/transferred into nominal. Retaining constant velocity 350-360 km/h and the flaps, released to 15°, produce the set of height/altitude 800 m, after which aircraft it is translate/transferred into the mode/conditions of acceleration/dispersal to the speed of steady climb. In the process of acceleration/dispersal at speed not more than 400 km/h the flaps are removed completely.

With takeoff in night time or to the side of the populated areas, arrange/located at removal less than 6.5 km of the beginning of takeoff/run-up, and also during flight from foreign airports with the established/installed limitations on noise it is necessary by the curve/graphs, given to Fig. 13 and Fig. 14, to determine expected levels of the maximum noise, also, if necessary to refine for specific conditions the height/altitude of a change in the engine power rating and the mode/conditions, which ensures acceptable noise levels.

For a reduction/descent in the noise is allow/assumed a decrease in the mode/conditions to 80° in IP-33 after completion of retraction of flaps to 15° and at height/altitude not less than 150 m. With the very close arrangement of the populated areas it is necessary to decrease down to the necessary value the engine power rating on height/altitude not less than 150 m, after which it is allow/assumed retraction of flaps from 30° to 15° with the preservation/retention/maintaining of speed 350-360 km/h.

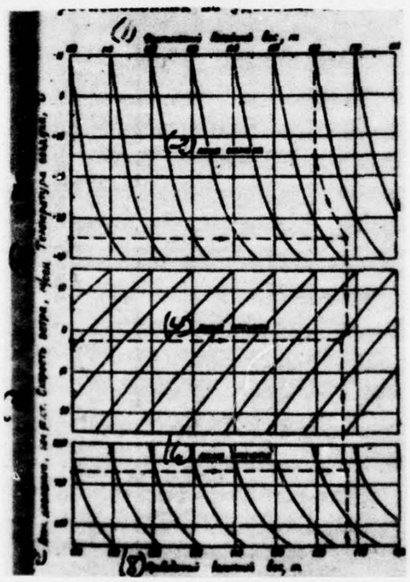
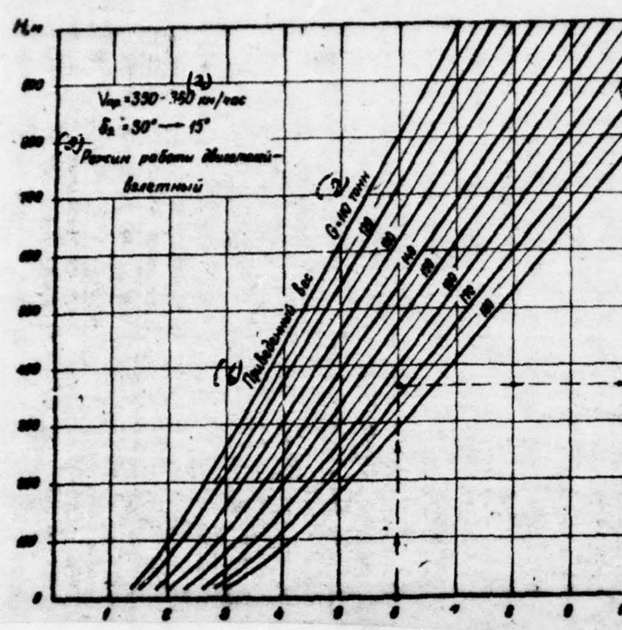


Fig. 13. Nomogram for determining the given weight of aircraft Il-62.

Key: (1). Actual takeoff weight, t. (2). reference line. (3). Temperature of air, °C. (4). reference line. (5). Wind velocity, m/s. (6). reference line. (7). Atm. pressure, mm Hg. (8). Given takeoff weight, t.

Page 26.



Максимальный шум, создаваемый на местности					
PNдБ	дБ(A)	EPNдБ	PNдБ	дБ(A)	EPNдБ
Взлетный режим			Режим 80° по ИП-33		
101,0	90,0	105,0	92	81,0	97,5
102,0	91,5	105,5	93,0	81,5	98,0
103,0	91,5	106,0	94,5	83,0	99,0
104,0	92,0	106,5	95,0	84,0	100,0
105,0	93,0	107,0	97,0	85,0	101,0
106,0	94,0	107,5	97,5	86,0	101,5
107,0	95,0	108,0	99,0	87,0	102,0
108,0	96,5	109,0	100,5	88,5	102,5
109,0	97,5	110,0	102,0	90,0	104,0
111,0	99,0	111,0	103,5	91,0	105,0
112,5	101,0	112,0	106,0	93,0	[illegible]
115,0	102,5	113,0	107,5	94,5	107,0
117,0	105,0	[illegible]	[illegible]	96,5	108,5
120,0	107,5	117,0	113,6	98,5	[illegible]
124,5	110,0	119,5	117,5	103	113,0

Fig. 14. Trajectories and the noise, created in locality with the

takeoff of aircraft Il- 62.

Key: (1). Maximum noise, created at locality. (2). km/h. (3). The operating mode of engines - takeoff. (4). Takeoff conditions. (5). Mode/conditions 80° on IP-33. (6). Given weight. (7). tons. (8). Ci.

Page 27.

In this case in all cases the aircraft must continue climb with rate of climb not less than 2.5 m/s.

The height/altitude of a change in the engine power rating and the mode/conditions, providing levels of noise, close to permissible as for other aircraft, are determined from known values of actual takeoff weight of aircraft, temperature, wind and atmospheric pressure of the earth/ground, and also the removal/distance of the populated area from the beginning of takeoff run.

An example of calculation is shown on the given curve/graphs by dotted lines with rifleman/pointers for the following conditions:

the takeoff weight of aircraft. . . . .-160 t, the temperature of air. . . . .+35°C,

the is component of head wind. . . . .-2.5 m/s,

atmospheric pressure. . . . .-730 mm Hg,

distance of populated point/item from the beginning of takeoff/run-up. . . . . .-6.0 km.

For these conditions the given weight is equal approximately to 167 t. For providing the accepted as allowable level, for example, 102 PN dB, decrease of the operating mode of engine to 80° on IP-33 it is necessary to manufacture at height/altitude 350 m, by continuing climbing flight at constant velocity 360 km/h. After the flight/span of the populated area or set of height/altitude 800 m the engines are translate/transferred into nominal mode and in the process of the acceleration/dispersal of aircraft at speed not more than 400 km/h flaps are removed completely.

The dependence of the measured total noise levels and designed on the averaged spectra levels in PN dB EPN dB and dB (a) for the throttle engine power rating from the flight altitude of aircraft Il-62 is shown to Fig. 15.

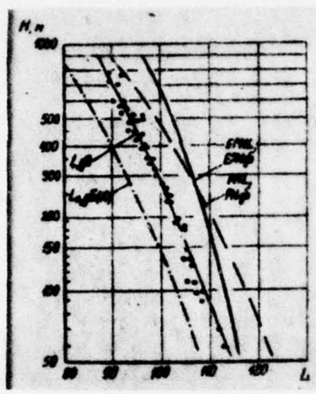


Fig. 15. The dependence of the levels of the maximum noise, created with the flight/span of aircraft Il -62, flight speed 350 km/h, the engine power rating is 80° on IP-33.

Page 28.

5. Characteristics and comparative evaluation of the effectiveness of applied procedures of piloting.

Key: (1). Aircraft type. (2). Fundamental characteristics. (3). A quantity is the type of engines. (4). Maximum takeoff weight, t. (5). Position of flaps with takeoff, deg. (6). Speed of the initial set of height/altitude, km/h. (7). Height/altitude of the beginning of acceleration/dispersal with intermediate retraction of flaps, m. (8). Position of flaps after intermediate retraction, deg. (9). Flight speed with flaps deflected to intermediate position, km/h. (10). Standard height/altitude of a change in the engine power rating from takeoff to nominal, m. (11). Height/altitude of the beginning of acceleration/dispersal and retraction of flaps to $\delta_{з}$ = 0°, m. (12). Noise level, regulated by standard ICAO at the control point, bred at removal/distance 6.5 km of the beginning of takeoff/run-up, EPN dB. (13). Height/altitude above the control point 6.5 km with takeoff with the preservation/retention/maintaining of the maximum engine power rating, m. (14). Noise level at control point 6.5 km in the engine operation under maximum conditions, (15). Throttle engine power rating on regular instruments. (16). r/min. (16a). on (17). Noise level at control point 6.5 km in the engine operation on throttle mode/conditions, EPN dB. (18). Reduction/descent in the noise za.scet, the throttling/choking of engines, EPN dB. (19).

The basic cell/elements, comparative characteristics and acoustic effectiveness of the procedures of piloting Soviet aircraft with a decrease in the noise in locality with takeoff are shown in table 3.

Table 3.

(1) Тип самолета / (2) Основные характеристики	Ту-I04	Ту-I24	Ту-I34	Ил-62
I	2	3	4	5
(3) Количество и тип двигателей	2ТРД РД-3М	2ТРДД Д-20П	2ТРДД Д-30	4ТРДД НК-8-4
(4) Максимальный взлетный вес, т	76	38	45	I60
(5) Положение закрылков при взлете, град.	I0	I0/20	I0/20	30
(6) Скорость начального набора высоты, км/час	350	300/270	300/280	330
(7) Высота начала разгона при промежуточной уборке закрылков, м	-	-	-	I20
(8) Положение закрылков после промежуточной уборки, град.	-	-	-	I5
(9) Скорость полета с закрылками, отклоненными в промежуточное положение, км/час	-	-	-	345
(10) Стандартная высота изменения режима работы двигателей со взлетного на номинальный, м	200	300	400	400
(11) Высота начала разгона и уборки закрылков до δз = 0°, м	500	500	800	800
I	2	3	4	5
(12) Уровень шума, [illegible] в контрольной точке, [illegible] на удалении 6,5 км от начала разбега, EPNдб	99	94	95	I04
(13) Высота над контрольной точкой 6,5 км при взлете с [illegible] режима работы двигателей, м	350	480	640	440
(14) Уровень шума в контрольной точке 6,5 км при работе двигателей на максимальном режиме,	II8	I09	II0	I09
(15) Дроссельный режим работы двигателей по штатным приборам	n = 4I00 (16) об/мин	n = 88%	n = 88-90%	80° по ИП-33
(17) Уровень шума в контрольной точке 6,5 км при работе двигателей на дроссельном режиме, EPNдб	I08	I02	96	I03
(18) Снижение шума за счет дросселирования двигателей, EPNдб	I0	7	I4	6
(19) Минимальная высота дросселирования двигателей, м	I50	I50	I50	I50
(20) Минимальная высота разворота с целью снижения шума, м	200	I00	I00	200
(21) Минимальный радиус разворота при угле крена I5°, км	3,6	2,6	2,6	3,6

Minimum height/altitude of the throttling/choking of engines, m. (20). Minimum height/altitude of turn for the purpose of a reduction/descent in the noise, m. (21). Minimum radius of turn at the angle of bank 15°, of km.

Page 29.

In accordance with standard ICAO [2] the noise with takeoff is regulated at the control point, arrange/located at removal/distance 6.5 km of the beginning of takeoff/run-up. The allowed value of the noise depends on the takeoff weight of aircraft, whereupon as the initial conditions is accepted the temperature of ambient air, equal to -25°C, atmospheric pressure -760 mm Hg, calm. The comparison of the noise levels, regulated by standard ICAO, at the point indicated during set by the aircraft of height/altitude with actual level of the noise, created by the aircraft of different types, it is shown to Fig. 16.

It should be noted that as the characteristic rate of climb for Soviet aircraft is selected the speed, equal to V_2 - (20-30) km/h. For small aircraft of the type that-124 and that-134 this value of velocity, selected for the maximum takeoff weight, for the purpose of simplification piloting is utilized also with takeoff with smaller takeoff weights.

Page 30.

This allows with an insignificant deterioration in the acoustic effectiveness to decrease the pitch angle, which with an increase in the thrust-weight ratio can considerably increase, which makes survey/coverage of forward half sphere worse and can cause inconveniences for passengers. It is considered that for the majority of aircraft types the angle of pitch must not exceed 15°. The climb without retraction of flaps (are deflected to takeoff position) also makes it possible to reduce the angle of pitch.

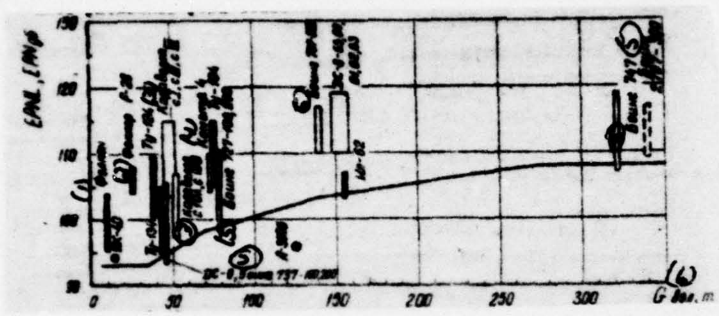


Fig. 16. Comparison of actual noise levels, created by the aircraft of different types at the control point, arrange/located at removal/distance 6.5 km of the beginning of takeoff/run-up, with the regulated standarls ICAO.

Key: (1). Falcon. (2). Fokker. (3). Caravelle. (4). Comet. (5). Boeing. (6). TO. t.

Page 31.

III. Some results of investigations in the evaluation of the expected characteristics of the noise of SPS.

Analyzing materials of works, containing the results of the studies of expected noise levels in locality during operation SPS, and also the possible methods of their reduction/descent it is important to emphasize the following special feature/peculiarities SPS, which relate to the characteristics of the created noise and the methods, utilized for its reduction/descent.

1. The operational methods, directed toward a reduction/descent in the noise SPS, in principle do not differ from those used for subsonic passenger aircraft with jet engines.

2. Comparatively high values of thrust-weight ratio SPS makes it possible to accomplish steeper trajectories of the initial climb with takeoff. The high altitude of the flight/span above the control point with takeoff in conjunction with the throttling/choking of engines makes it possible to achieve at this point of the noise levels, close to those observed for subsonic aircraft.

3. Preferable preferential for SPS TRD instead of TRDD substantially increases noise at the points, arrange/located from the side runway, with the takeoff of aircraft.

As illustration on Fig. 17 and Fig. 18 is shown according to the results [7], [17] the comparison of the take-offs path SPS and of typical subsonic aircraft, and also the created in this case noise. Values of the areas, subjected to the noise effect of various levels with takeoff SPS and of subsonic aircraft, are given in table 4 [17].

A reduction/descent in the noise as a result of the throttling/choking of engines with takeoff SPS, as can be seen from Fig. 19, can reach 12 PN by dB. On Fig 19 are shown to take-off path and the levels of the maximum noise under trajectory in the engine operation on takeoff conditions with the application/use of afterburning throttle mode/conditions, the ensuring the gradient of set height/altitude, equal to 6o/o [19].

The comparison of the characteristic dependences effective level of received noise (in EPN dB), created in locality with takeoff and reduction/descent for landing SPS (solid lines) and subsonic passenger aircraft with four TRD or TRDD with low bypass ratio (dotted lines) from pressure to the flying aircraft is shown to Fig. 20 [19].

Table 4.

(1) Уровень шума, PNдб	>120	110-120	100-110	90-100	>90
(2) Площадь, заключенная кривыми равных уровней для СПС, км²	5,0	6,5	18	70	~ 100
(3) Площадь, заключенная кривыми равных уровней для дозвукового самолета, км²	1,5	2,5	10	50	~ 65

Key: (1). Noise level, PN dB. (2). Area, included by the curves of equal levels for SPS, km². (3). Area, included by the curves of equal levels for subsonic aircraft, km².

Page 32.

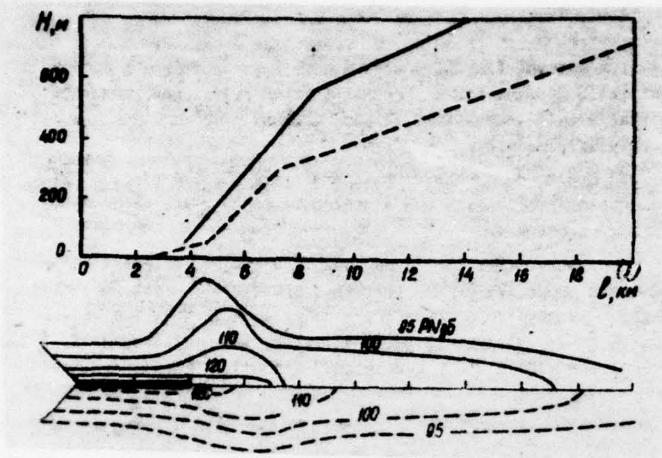


Fig. 17.

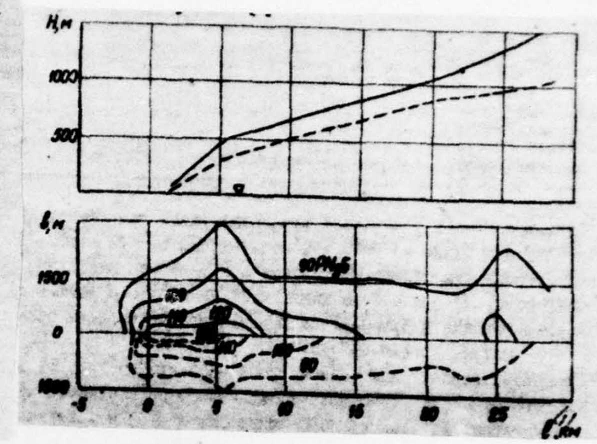


Fig. 18.

Fig. 17. Trajectories and the noise, created in locality with takeoff SPS (solid lines) and subsonic transport aircraft with TRDD (dotted lines) according to the data [7].

Key: (1). km.

Fig. 18. Trajectories and the noise, created in locality with takeoff SPS (solid lines) and subsonic aircraft (dotted line) according to the data [17].

Key: (1). km.

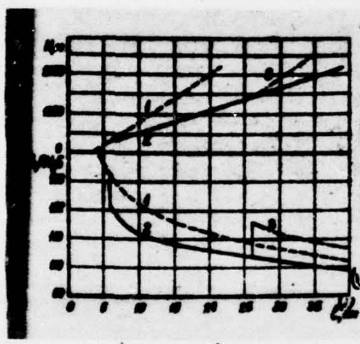


Fig. 19.

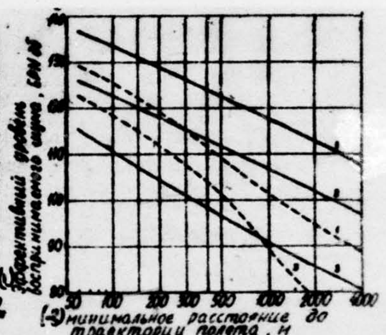


Fig. 20.

Fig. 19. The trajectories and levels of the maximum noise under trajectory in the engine operation on takeoff and throttle mode/conditions. 1 - the takeoff engine power rating, the gradient of the set of height/altitude 13o/o; 2 - the throttle engine power rating, the gradient of the set of height/altitude 6o/o; 3 - the restoration/reduction of takeoff mode/conditions at height/altitude 1500 m.

Key: (1). km.

Fig. 20. Dependence of the noise levels in EPN dB from the minimum removal/distance to trajectory of flight SPS (continuous lines) and subsonic aircraft with 4 TRD or TRD with low bypass ratio (dotted lines). 1 - takeoff conditions; 2 - the throttle mode/conditions, which ensures gradient 6o/o; 3 - landing mode/conditions.

Key: (1). Effective level of the received noise, EPN dB. (2). the minimum distance to path of flight, m.

Page 33.

IV. Mathematical description of the task of the selection of optimum aircraft control with takeoff with a decrease in the noise in locality.

As already mentioned, among the used at this time methods of a reduction/descent in the noise of aircraft in locality important place is assigned to the special methods of piloting, the task of developing similar procedures of piloting with takeoff allow/assumes mathematical simulation and can be solved by the methods of the theory of optimum control [20].

The motion of the center of mass of aircraft let us describe by the system of differential equations.

Page 34.

$$\frac{dx}{dt} = f(x, U), \qquad (1)$$

where $x = (x_1, x_2, \ldots, x_3)$;

$f = (f_1, f_2, \ldots, f_3)$ are a vector function;

$U = (U_1, U_2, \ldots, U_6$ are steering functions;

$x_1 = V$ - flight speed; $x_2 = \theta$ - the flight path angle to the horizon; is an angle of rotation of trajectory; $x_4 = l$, $x_5 = h$ - moving coordinates; $U_1 = \alpha$ - angle of attack; $U_2 = \beta$ - slip angle; $U_3 = \gamma_c$ - the angle of high-speed/velocity bank/roll; $U_4 = \varphi$ - the angle of deflection of thrust vector; $U_5 = \delta_3$ - the angle of deflection of high lift devices; $U_6 = p$ - the engine thrust.

$$f_1 = \frac{P}{m}\cos(\alpha-\varphi)\cos\beta - \frac{X}{m}\sin\beta + \frac{Z}{m}\sin\beta - g\sin\theta;$$

$$f_2 = \frac{P}{mV}\left[\sin(\alpha-\varphi)\cos\gamma_c + \cos(\alpha-\varphi)\sin\gamma_c\cdot\sin\beta\right] -$$

$$\frac{X}{mV}\sin\beta\cdot\sin\gamma_c + \frac{Y}{mV}\cos\gamma_c - \frac{Z}{mV}\cos\beta\cdot\cos\gamma_c - \frac{g}{V}\cos\theta;$$

$$f_3 = -\frac{P}{mV\cos\theta}\left[\sin(\alpha-\varphi)\sin\gamma_c - \cos(\alpha-\varphi)\sin\beta\cdot\cos\gamma_c\right] -$$

$$\frac{X}{mV\cos\theta}\sin\beta\cdot\cos\gamma_c - \frac{Y}{mV\cos\theta}\sin\gamma_c - \frac{Z}{mV\cos\theta}\cos\beta\cdot\cos\gamma_c;$$

$$f_4 = V\cdot\cos\theta; \quad f_5 = V\cdot\sin\theta$$

where X, Y, Z are aerodynamic forces;

m = the mass of aircraft.

For contemporary jet aircrafts the total emitted acoustic power can be by the specific relationship

$$W = W_1 + W_2,$$

where W_1 - the acoustic power, emitted by exhaust jet;

W_2 - the acoustic power, emitted by compressor.

The effect of noise on population usually is determined by sound pressure level, by spectral composition and the duration of the effect of noise. To evaluate the irritating effect of noise in single flight/span of aircraft usually is applied EPNL - the effective level of the received noise. Taking into account a series of the simplifying assumptions accordingly criterion by the measure of the irritating **effect of noise can serve the value:**

$$A = \int_0^T \frac{W\Phi}{4\pi R^2} dt = \int_0^T J dt = \int_0^T 10^{L/10} dt . \quad (2)$$

where ϕ - is a directional characteristic of noise;

J - **noise** intensity;

R - distance from aircraft to control point;

L is a sound pressure level at control point.

Page 35.

Thus, the task of finding the optimum flight program is reduced to the determination of this solution of system of equations (1), which provides the minimum of integral criterion (2). Special feature/peculiarity of this task - limitation on phase coordinates, governing functions and maximum noise level. Task can be generalized for the case of the minimization of noise on terrain sector with the assigned boundaries.

For the solution of this problem is recommended the utilizing of the method of steepest descent, make it possible to investigate the optimum for noise flight conditions with the aid of computer. As a result is determined the most advantageous from noise program of the aircraft control taking into account the assigned limitations.

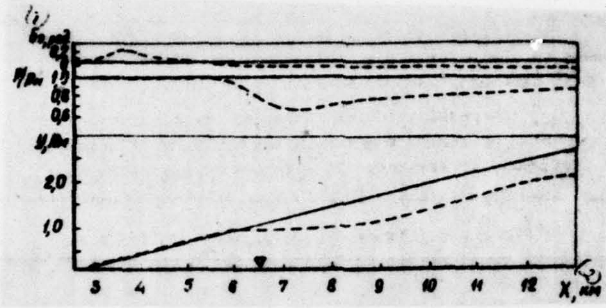


Fig. 21. Calculation of the optimum control SPS on computer from the conditions of providing the minimum noise in locality with the takeoff of aircraft.

Key: (1). be, rad. (2). km.

Page 36.

This method was used for determining the optimum takeoff paths of a series of aircraft. To Fig. 21 are given the calculated trajectories and the optimum control with takeoff SPS, obtained by employing procedure described above. Control point after rejecting at a distance of 6.5 km from the beginning of takeoff/run-up. The initial data on the characteristics of aircraft, necessary for the calculation, are borrowed from work [21]. Solid lines is shown takeoff without a reduction/descent in the engine power rating and takeoff configuration SPS. Optimum control of a series of the parameters from conditions of the maximum reduction/descent in the noise by represented dotted lines. The attained in this case reduction/descent in the noise exceeds value IO PN dB.

Thus, the proposed algorithm can be used both for determination of the most favorable take-off paths of promising aircraft, including SPS, and for the purpose of an increase in the effectiveness of the developed procedures of takeoff for the operable aircraft.

Pages 36 and 37.

REFERENCES. No typing.

I. Aircraft noise. Report of an international conference on the reduction of noise and disturbance caused by civil aircraft. London. HM Stationery Office. 1967.

2. International Civil Aviation Organisation. Special meeting on aircraft noise in the vicinity of aerodromes. Montreal, 25 November 1969. Report on Agenda Item 8. Noise 1969-WP/84. Paper 22.

3. Власов Е., Квитка В., Мельников Б., Мунин А. Ограничение шума самолетов. " Гражданская авиация", 1970, № 2, 29.

4. International Civil Aviation Organisation. Special meeting on aircraft noise in the vicinity of aerodromes. Montreal, 25 November 1969. Report on Agenda Item 4. Noise 1969-WP/89. Paper 10.

5. Мельников Б.Н. Снижение шума на местности при взлете самолета Ту-124. "Самолетостроение и техника воздушного флота". Республиканский межведомственный научно-технический сборник. Харьков, 1966, вып. 5, 157-161.

6. Parrell J.H. Procedures for estimating the effects of design and operational characteristics of jet aircraft on ground noise. Progress of NASA research relating to noise alleviation of large subsonic jet aircraft. NASA SP-189, 1968, 411-421.

7. Bird W.H., Wilde T.L. Aircraft noise and the community. Canad. Aeronaut. and Space J., 1968, 14, № 6, 201-209.

8. Richards E.J. Aircraft noise-mitigating the nuisance. Astronaut and Aeronaut, 1967, 5, № 1, 34-45.

9. Разумов И., Квитка В., Губкина Г. Характеристики шума, создаваемого самолетом Ту-104. " Гражданская авиация", 1958, № 2, 19-21.

10. Квитка В., Губкина Г. Новые исследования шума Ту-104 на взлете. "Гражданская авиация", 1958, № 7, 24-25.

11. СЭВ. Постоянная комиссия по транспорту. "Методика расчетного и экспериментального определения характеристик шума, создаваемого пассажирскими самолетами на местности". СССР, декабрь 1968 .

12. СЭВ. Секция № 5 по воздушному транспорту. Доклад по теме "Исследование вопросов уменьшения шума самолетов и разработка способов защиты от шума пассажиров, аэродромного персонала и жителей в окрестностях аэропортов", Материал, подготовленный делегацией СССР. Москва, 1965 .

13. Квитка В., Мельников Б. Полеты и акустика. "Гражданская авиация", 1967, № 2, 24-25.

14. Kvitka V.E., Mel'nikov B.N. Reduction and assessment of noise from civil aircraft. "Internat. Conf. Reduct. Noise and Disturb. caused Civil Aircraft, London, 1966." Paper INC/C3/P16.

BEST AVAILABLE COPY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER FTD-ID(RS)T-1455-77	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REDUCTION IN THE NOISE IN VICINITIES OF AIRPORTS WITH THE AID OF THE OPTIMUM METHODS OF PILOTING JET AIRCRAFT WITH TAKEOFF		5. TYPE OF REPORT & PERIOD COVERED Translation 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) V. Ye. Kvitke, B. N. Melnikov, V. I. Tokarev		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foreign Technology Division Air Force Systems Command U. S. Air Force		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 1972 13. NUMBER OF PAGES 70
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

01;12;20

ACCESSION for
NTIS Section ☑
DDC Section ☐
UNANNOUNCED ☐
JUSTIFICATION
BY
DISTRIBUTION/AVAILABILITY CODES
Dist. AVAIL. and/or SPECIAL
A

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE	ORGANIZATION	MICROFICHE
A205 DMATC	1	E053 AF/INAKA	1
A210 DMAAC	2	E017 AF/ RDXTR-W	1
B344 DIA/RDS-3C	8	E404 AEDC	1
C043 USAMIIA	1	E408 AFWL	1
C509 BALLISTIC RES LABS	1	E410 ADTC	1
C510 AIR MOBILITY R&D LAB/FIO	1	E413 ESD	2
		FTD	
C513 PICATINNY ARSENAL	1	CCN	1
C535 AVIATION SYS COMD	1	ETID	3
C557 USAIIC	1	NIA/PHS	1
C591 FSTC	5	NICD	5
C619 MIA REDSTONE	1		
D008 NISC	1		
H300 USAICE (USAREUR)	1		
P005 ERDA	1		
P055 CIA/CRS/ADD/SD	1		
NAVORDSTA (50L)	1		
NASA/KSI	1		
AFIT/LD	1		